GAMMA-COLL

INNOVATIVE TECHNIQUES FOR TREATMENT OF COLLAGEN MATRICES WITH GAMMA RADIATIONS AS GREEN ALTERNATIVE

Program: P1 – Development of the national R&D system

Subprogram: 1.1 Human resources,

Project type: Postdoctoral research project

Project code: PN-III-P1-1.1-PD-2021-0189

Financing contract: PD 71/2022

Contractor: National Research and Development Institute for Textiles and Leather - I.N.C.D.T.P. Bucharest, Division: Leather and Footwear Research Institute - I.C.P.I.

Start date of contract: 01.04.2022

End date of contract: 31.03.2024

Project duration: 24 months

Total value of the contract: 250.000,00 lei

Project director: Dr. Maria Stanca, CS III

General objective of the project:

The main objective of the Gamma-Coll project is to investigate changes in collagen due to the ions and free radicals generated by gamma radiation and its influence on leather in various chemical environments, in order to develop experimental models for new ecological technologies. The estimated environmental impact refers to total reduction of total dissolved solids and chlorides from effluents, reduction of processing time and obtaining finished products of higher quality, free of potential allergens.

The specific objectives of the project are:

- Developing a process for preserving raw hides, wet-blue/ wet-white or crust hides using gamma radiations
- Developing a process for crosslinking collagen matrices
- Developing an experimental model for ecological leather tanning in order to obtain higher quality products.

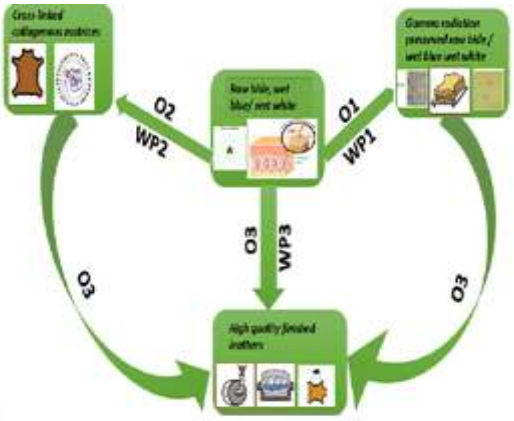

Fig.1 Flowchart of project objectives

The GAMMA-COLL project contributes to developing unconventional, ecological techniques for the preservation of raw, wet-blue and crust hides or for crosslinking collagen using gamma radiations, as ecological alternative.

Stage I: *Developing an ecological process for the preservation of raw, wet-blue /wet-white or crust hides by gamma radiation.*

The objective of stage I of the GAMMA-COLL project was to establish the optimal dose of gamma radiation for the preservation of hides in various stages of processing. In order to achieve this objective, hides were irradiated at different doses and then characterized.

Raw hides were irradiated at 10, 20 and 25 kGy to establish the optimal dose for hide preservation. Irradiated raw hides and the non-irradiated control were vegetable tanned.

Wet-blue and crust hides were irradiated at 5, 10 and 15 kGy to establish the optimal dose for hide preservation.

Raw, wet-blue and crust hides were analysed physico-chemically, physico-mechanically and by spectroscopic methods.

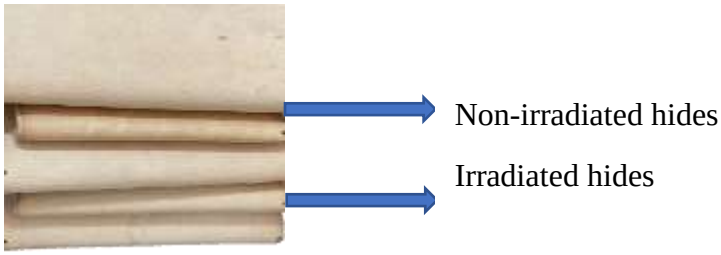

Fig. 2 Vegetable tanned leather after gamma irradiation

Results:

Web of Science-indexed journal articles: Maria Râpa, Traian Zaharescu, Laura Mihaela Stefan, Carmen Gaidau, Ioana Stanculescu, Rodica Roxana Constantinescu and Maria Stanca, Bioactivity and Thermal Stability of Collagen–Chitosan Containing Lemongrass Essential Oil for Potential Medical Applications, Polymers 2022, 14, 3884.

Daniela Bala, Iulia Matei, Gabriela Ionita, Dragos-Viorel Cosma, Marcela-Corina Rosu , Maria Stanca, Carmen Gaidau, Maria Baleanu, Marian Virgolici and Ioana Stanculescu, Luminescence, paramagnetic and electrochemical properties of copper oxides-decorated TiO2/graphene oxide nanocomposites, -pending publication

Patent application: Stanca Maria, Ionita Elena Gabriela, Stanculescu Ioana-Rodica, Cutrubinis Mihalis, Process of crosslinking hides by gamma irradiation, A/00741/17.11.2022

Stage II: *Development of an ecological process for the cross-linking of collagen matrices using gamma radiation and the development of an experimental model of ecological tanning to obtain superior quality products - the first part*

The objective of stage II of the project was to establish the optimal dose of gamma radiation suitable for the crosslinking of collagen matrices with crosslinking agents from different classes of tannins, and the replacement of some polluting and/or potentially allergenic reagents in the tanning process.

Crosslinking agents from three different classes: hydrolysable tannins, condensed tannins and iridoids were used for the crosslinking of collagen matrices. The collagen matrices mixed with the crosslinking agents used were exposed to gamma radiation in order to establish the degree of crosslinking, depending on the radiation dose. The doses of gamma radiation used were 3, 5 and 10 kGy.

The crosslinking degree of the collagenous matrix varied depending on the dose of radiation used, the tanning agent and the degree of structured order of protein. Microbial load analysis showed that collagen matrices based on collagen hydrolysate were sterile at a dose of 10 kGy when it was crosslinked with gallic acid and tannic acid due to the higher number of hydroxyl groups. The replacement of alkaline chemicals from the preliminary processes of tanning operation led to a decrease in the pollution load and the toxicity in the effluents.

Results:

ISI indexed articles: Stanca, M.; Gaidau, C.; Zaharescu, T.; Balan, G.-A.; Matthew, I.; Precupas, A.; Leonties, A.R.; Ionita, G. Physico-Chemical Changes Induced by Gamma Irradiation on Some Structural Protein Extracts. Biomolecules 2023, 13, 774. https://doi.org/10.3390/biom13050774

M. Stanca, G.E. Ionita, C. Gaidau, I. Quaratesi, N. Proietti, B. Lungu, T. Zaharescu, E. Badea, Ecological method for rawhide conservation using gamma radiation, Journal of Cleaner Production – submitted for publication

The results obtained were disseminated by participating in three international conferences

- M. Stanca, G.E. Ionita, C. Gaidau, I. Stanculescu, T. Zaharescu, Development of an ecological process for the preservation of rawhides using gamma radiations, 10th International Conference on Sustainable Solid Waste management, June 21-24, 2023, Chania, Greece

- M. Stanca, C. Gaidau, G. Ionita, R. Constantinescu, B. Rusu, M. Cutrubinis, Development of an ecological process for the preservation of wet blue and crust leather using gamma radiations, 25th International Conference on Materials, Methods and Technologies, August 17-20, 2023, Burgas, Bulgaria

- M. Stanca, E.-G. Ionita, C. Gaidau, I. Matei, A. Precupas, A. Leonties, T. Zaharescu, Physico-chemical changes induced by Gamma irradiation on some structural protein extracts, 17th International Conference of Physical Chemistry – ROMPHYSCHEM, September 25-27, S2023, Bucharest Romania

Stage III: *Development of an experimental model of ecological tanning for obtaining superior quality products – second part*

The objective of the stage III of the project was the characterization and evaluation of the physico-chemical and physico-mechanical characteristics of the leather obtained using the ecological tanning process.

It was observed that the leather obtained using the ecological tanning process has a similar quality to those obtained through a classic vegetable tanning technology, the physico-chemical and physico-mechanical characteristics of the obtained leather being slightly improved due to the stronger interaction between the irradiated collagen and tannin.

The replacement of sodium chloride, which is corrosive and difficult to remove from wastewater, in the conservation and pickling stages leads to cleaner effluents, which corresponds to the objectives of sustainable development, Directive 6, "Ensuring the availability and sustainable management of water and sanitation for all". This proposes the improvement of water by minimizing the release of substances (dangerous and non-dangerous) and increasing its safe recycling and reuse on a global level".

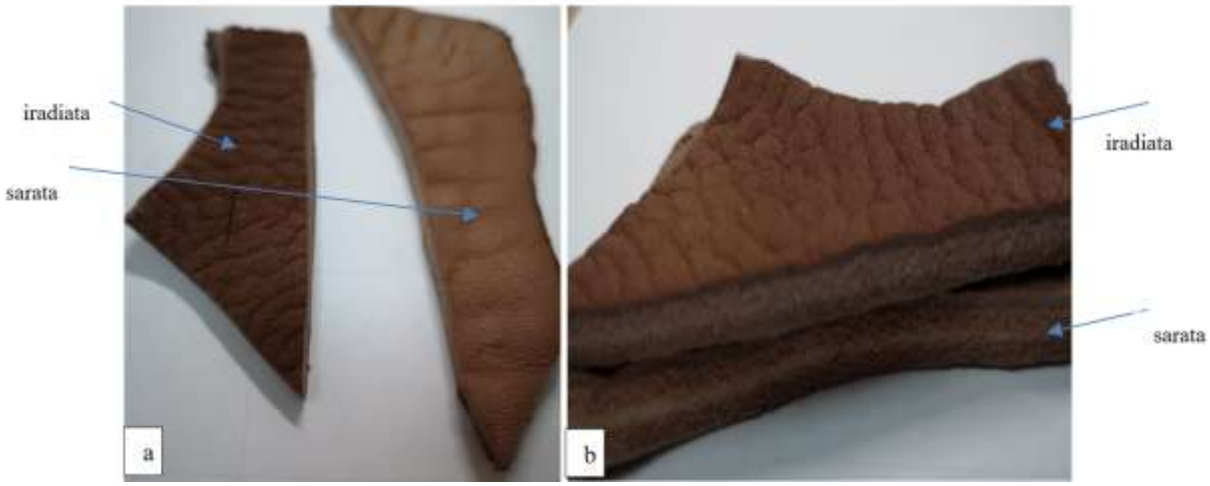

Figure 3. Crust leather obtained by vegetable tanning of the hides, preservation by salting and by gamma irradiation a) grain and b) section

Results:

ISI indexed article: Gaidau C., Râpă M., Ionita G., Stanculescu I. R., Zaharescu T., Constantinescu R.R., Lazea-Stoyanova A., Stanca M., "The Influence of Gamma Radiation on Different Gelatin Nano-fibers and Gelatins" Gels, 2024, 10(4), 226; https://doi.org/10.3390/gels10040226